Space Weather Technical Forecast

Issued on Wednesday, 14 December 2022 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate Radio Blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with a maximum C3 flare peaking at 13/2325 UTC from the trailer of AR3153 as it rotates off the disc. There are twelve sunspot regions on the Earth-facing disc, although most of these are small and simple with little sign of development. The other notable regions are AR3160 in the north-centre, AR3163 in the southeast and AR3165 in the southwest. AR3160 has continued to increase in areal extent, despite maintaining a relatively simple magnetic structure. AR3163 is likewise a moderately sized region with slow developing of intermediate and trailer spots observed, but also of a simple bipolar structure. AR3165 is a smaller region, but also magnetically more complicated, with some ongoing development in a mixed polarity intermediate region, and also a reverse (negative) polarity sunspot near its positive trailer. No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed at L1 by DSCOVR and ACE has declined from around 450 km/s to below background levels below 400 km/s. Density was mostly below average. The total IMF, Bt, was weak at 7nT or below. The north-south component of the IMF, Bz, varied weakly between -6nT and +4 nT. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Background to Moderate levels, with peak 370 pfu at 13/1710 UTC. The associated 24-hour fluence remained steady, and below Active (1e8 integrated pfu). Observed fluence at 14/0000 UTC was 8.89e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low with occasional C-class flares, but with a daily chance (40%) of rising to Moderate with isolated M-flares possible (R1-R2 Radio Blackouts).

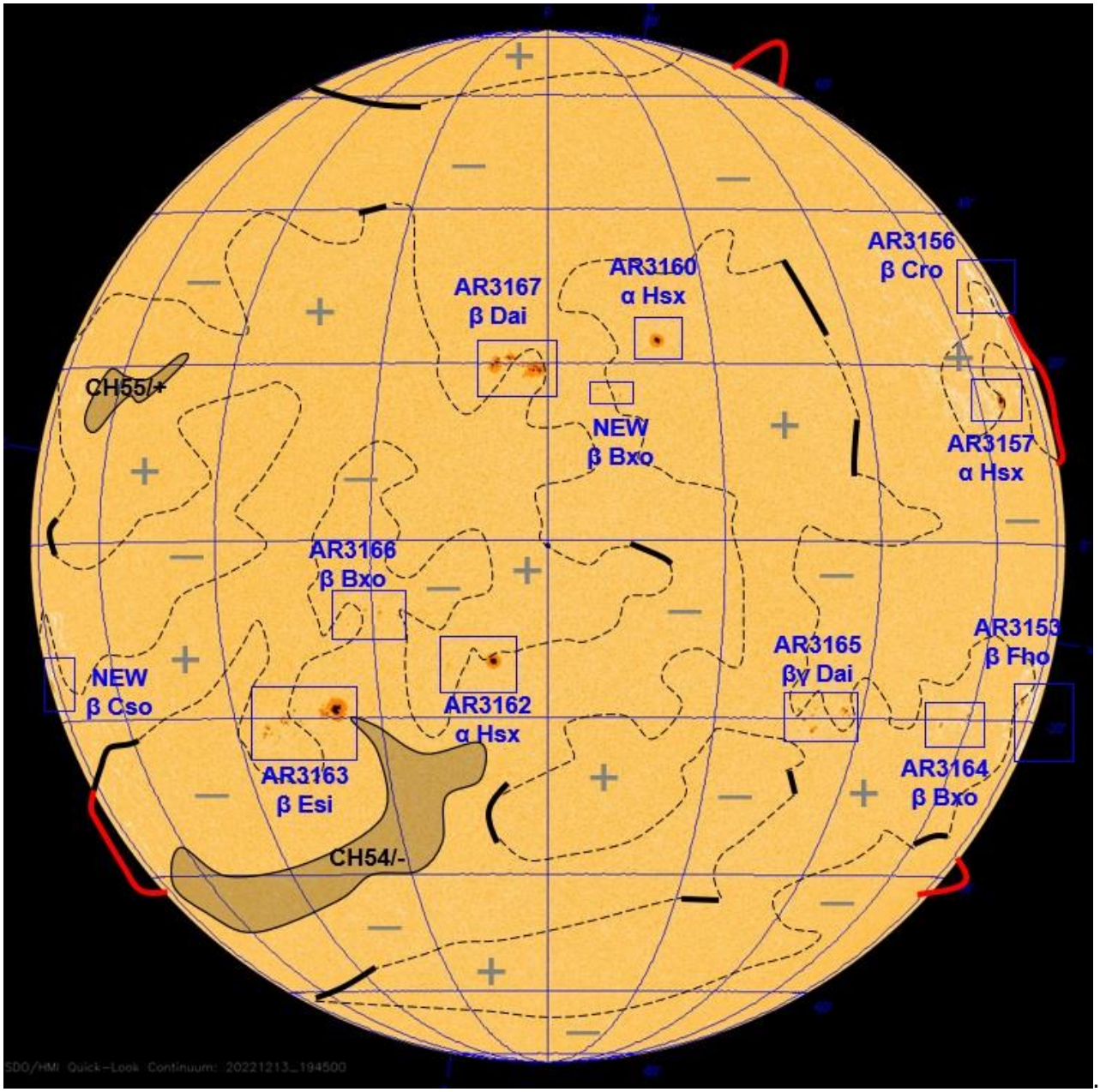
Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds are expected to remain at Background to Slightly Elevated with no notable enhancements expected. Quiet geomagnetic activity expected with only a slight chance of isolated Unsettled intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels throughout. There is a very slight chance of rising towards the S1 level with the occurrence of any notable flares. High energy (greater than 2 MeV) electron flux is currently at background to moderate flux levels, with only a slight chance of briefly reaching High levels each day. The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

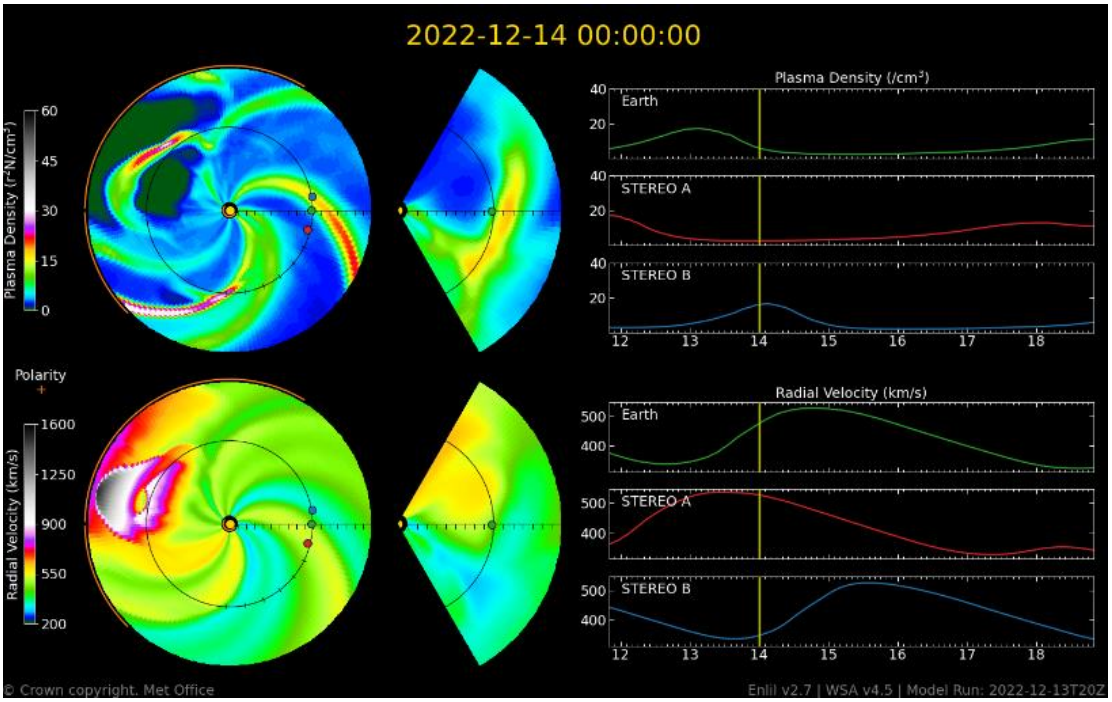
There are no Earth-directed CMEs.

Solar winds are expected to be at background to slightly elevated, with no significant enhancements forecast. While MOSWOC enlil does suggest the possibility of some connection to the fast wind, likely due to a now impossible to see CH in the northwest disc, this has been discounted due to enlil verifying poorly to current conditions. It is likely that any such fast wind, if it was there, is passing above the Earth. This is supported by the lack of enhancement observed at STEREO A, which is 1 degree north of the ecliptic whilst Earth is currently at 1 degree south.

Quiet geomagnetic activity expected with only a slight chance of isolated Unsettled intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil showing CH enhancement, but expected to pass north of Earth.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

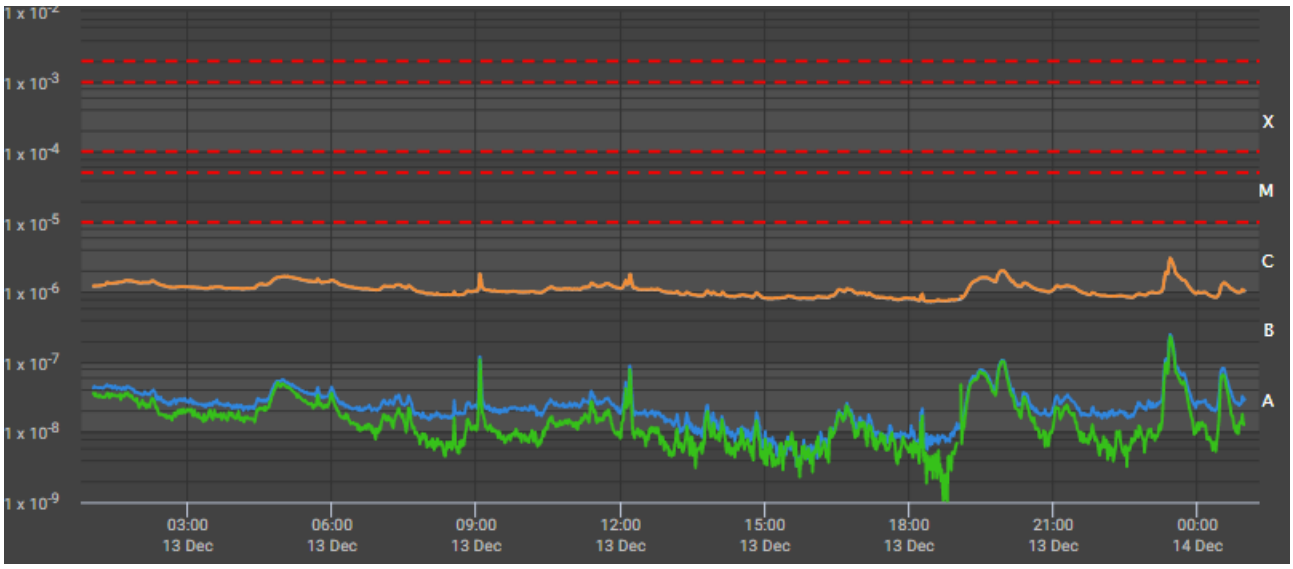
There are a total of twelve sunspots on the Earth-facing disc, however the vast majority of these are small and simple with activity likely to be Low, with a chance of rising to Moderate due to any M-flaring. There are currently three regions with ongoing signs of development.

AR3160 Dai/Beta in the north-centre disc has been growing in the last 24 hours, although it has maintained a simple east-west bipolar configuration. AR3163 Eai/Beta is also a reasonably sized region in the southeast, with the spot mainly comprised of a moderately sized leader, followed by smaller but developing intermediate and trailer spots. AR3165 Dai/Beta-gamma is a smaller region in the southeast, but with ongoing growth in a mixed polarity intermediate region, coupled with a slightly more complex magnetic field due to a reverse polarity region near its trailer. Further development of this spot would increase the likelihood of notable flaring.

There are two further regions of note. AR3153 Fho/Beta is the largest region, but now rotating off the disc with the leader over the eastern limb, This remained a stable region throughout its transit with no significant flaring. A further new region (preliminary analysis of Cso/Beta) is also likely rotating onto the southeast disc, but is currently very difficult to analyse due to its location. However, some bright looping is evident on the southeast disc limb on SDO imagery (e.g.aia-171).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES-16/17 X-ray Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

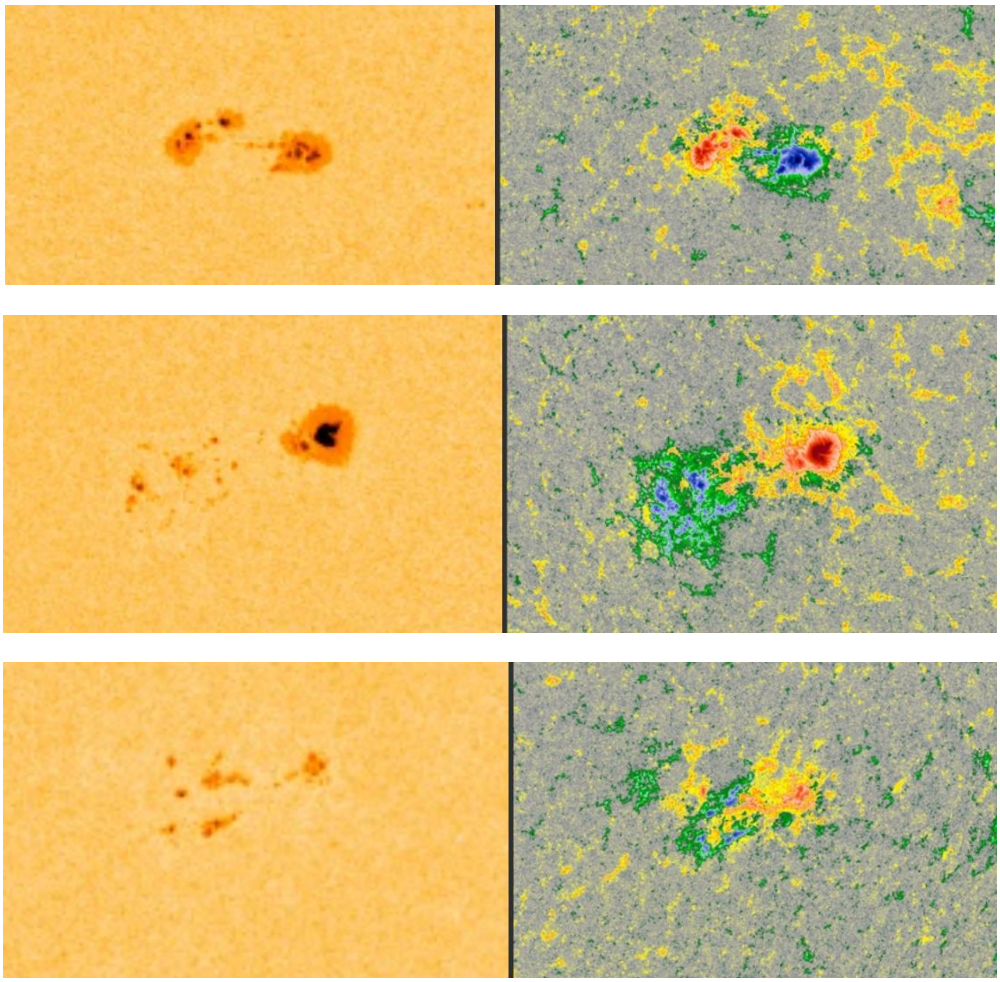
© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 is expected to remain at background levels throughout. Despite their magnetic simplicity, the number of sunspots on the Earth-facing disk, and especially in the western hemisphere, gives a daily chance of M-flares. This subsequently gives a slight chance of the proton flux increasing due to any such flare activity, and perhaps approaching or exceeding the S1-level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO Intensitygram and Magnetogram of AR3160 (top), AR3163 (middle) and AR3165 (bottom)



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux, as observed by GOES-16, is currently varying between Background and Moderate levels. With no significant solar wind enhancements expected, these electron flux levels are expected to persist through the period, with only a slight chance of briefly reaching high at the diurnal observation peak.

The associated 24 hour fluence is forecast to persist below the active threshold (1e8 integrated pfu). This is supported by REFM which is currently giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Flux and Fluence with REFM

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.